Dehydration Resistant And Dimensionally Stable High Performance Membrane, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

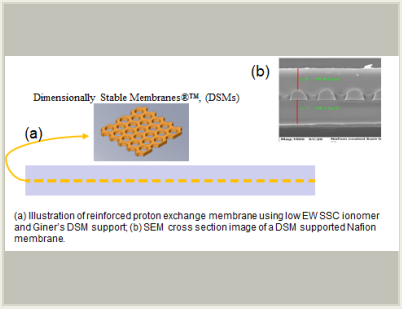
In several technologies within NASA's In Situ Resource Utilization (ISRU) systems, such as fuel cell, water electrolysis and gas/water separations etc., polymeric membranes, especially proton exchange membranes (PEM), play an important role. These membranes are generally hygroscopic, subject to swelling in the presence of humidity or water. When restrained membranes undergo a hydration/dehydration changes, stresses are then generated which can lead to membrane failure. Given the harsh surface environmental conditions on the moon and Mars, more dehydration resistant and dimensionally stable PEM materials are highly desirable for better performance and durability and to allow for long term dry storage and delivery of ISRU systems.

Giner herein proposes to create a reinforced proton exchange membrane using a low equivalent weight (EW) short-side-chain (SSC) ionomer and Giner's Dimensionally Stable Membranes®™ (DSM) matrix support. In this design, the DSM support is filled with low EW SSC PFSA ionomers. With the added strength inherent in the DSM support, these PEMs can be made thinner and be impregnated with a high-acid-content low EW ionomer to improve the water retention and maintain excellent dimensional stability. Our proposed design has multiple advantages to address the dehydration issues for NASA applications and is expected to achieve improved performance and reduced cost. The water retention property will be greatly enhanced by using a low EW SSC ionomer compared to Nafion. The other associated properties, e.g. protonic conductivity, dimensional stability, wet-dry cycling durability, and freeze/thaw thermal cycling durability are expected to improve significantly as well. In addition, our design has a more cost effective fabrication and ease of scaling up than Gore-Select membrane using e-PTFE support and other nanofiber electrospinning methods.

Anticipated Benefits

The developed high performance reinforced proton exchange membranes can be used in the vapor feed electrolyzers, PEM fuel cells and regenerative fuel cells etc., which found broad applications in NASA, including but not limited to Lunar and space stations, satellites, high altitude aircraft.

This membrane material can be readily applied to fuel cells employed in vehicles, portable devices and remote installations. The unique properties of the supported membrane will also facilitate the commercialization of these technologies. The advanced membranes can also be used in applications including hydrogen filling stations, and chlor-alkali process etc.



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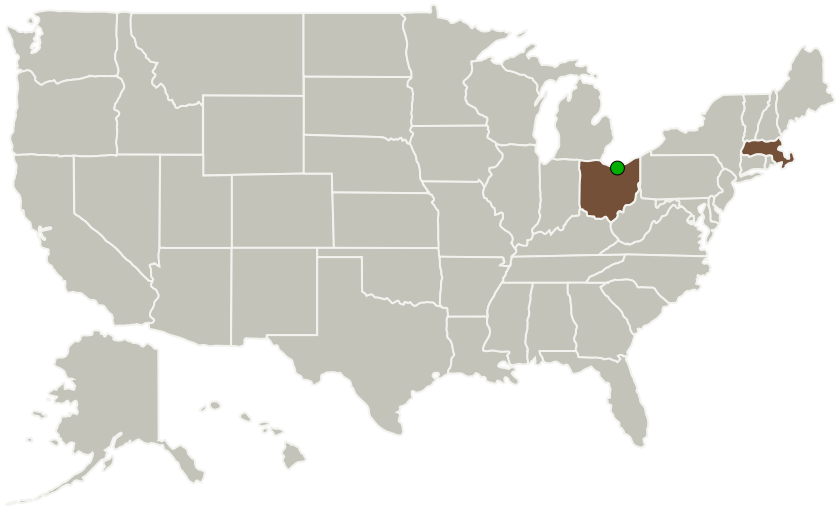
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Giner, Inc.	Lead Organization	Industry	Newton, Massachusetts
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Massachusetts	Ohio

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141325)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Giner, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

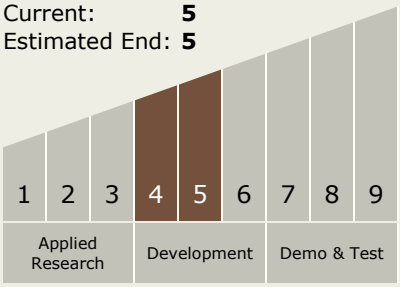
Carlos Torrez

Principal Investigator:

Chao Lei

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**



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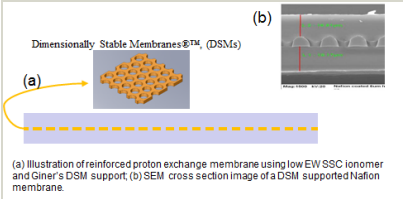
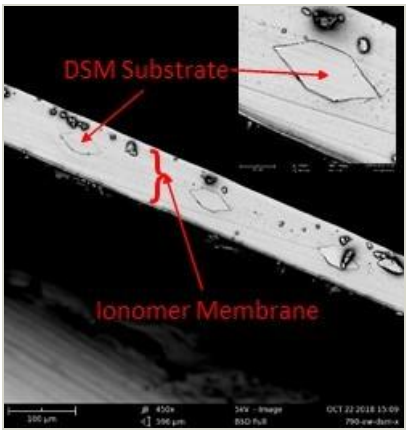
Images



Briefing Chart Image
Dehydration Resistant And Dimensionally Stable High Performance Membrane, Phase I *(https://techport.nasa.gov/image/133913)*



Final Summary Chart Image
Dehydration Resistant And Dimensionally Stable High Performance Membrane, Phase I *(https://techport.nasa.gov/image/131627)*

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.3 Resource Processing for Production of Mission Consumables

Target Destinations

The Moon, Mars